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GB 1572454 A GB 0934013 A US 4358844 A

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INT CL<sup>5</sup> H04B 7/216, H04J 13/00  
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## (54) Spread spectrum analog signal communication system

(57) A spread spectrum communication system comprises a transmitter (1) including a spreading code generator (8) and mixer (5) means to which a spreading code produced by the said generator and the analog signal for transmission are fed, thereby producing a spread spectrum signal for transmission. A receiver (2) includes a mixer (11) to which the received spread spectrum signal is fed, together with a de-spreading code from generator (12) corresponding to the spreading code, thereby recovering the transmitted analog signal. A unique code is used for each user of the system.

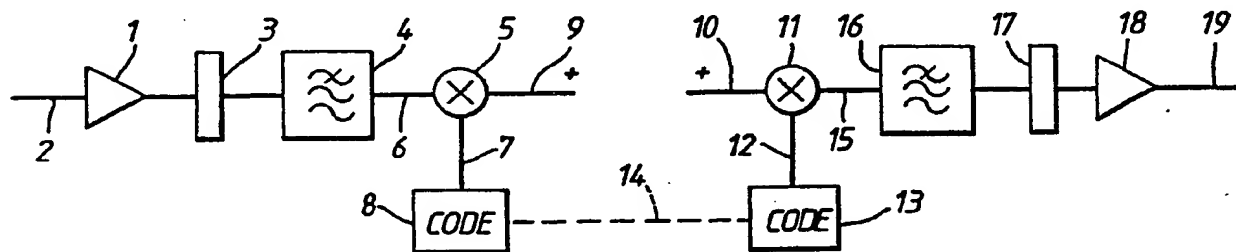


Fig.1

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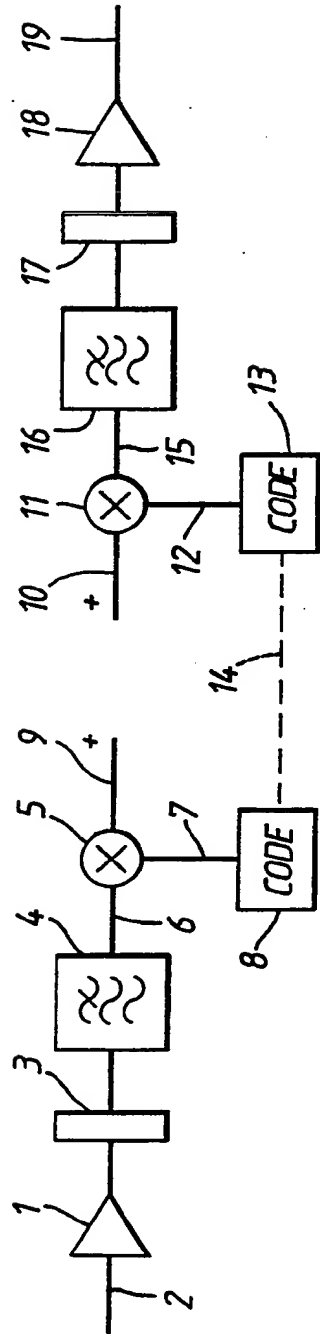


Fig.1

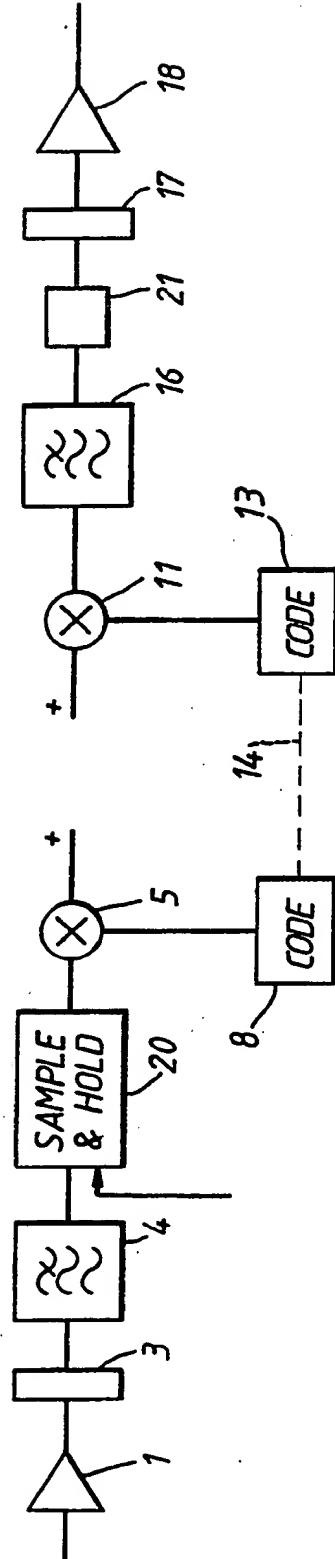
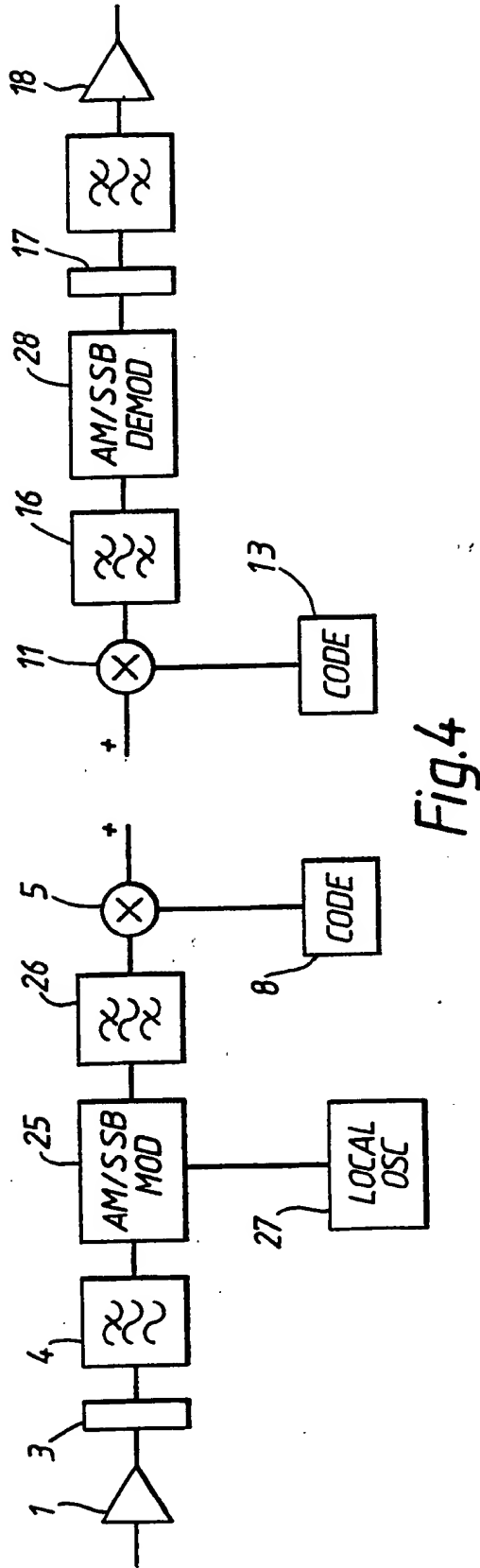
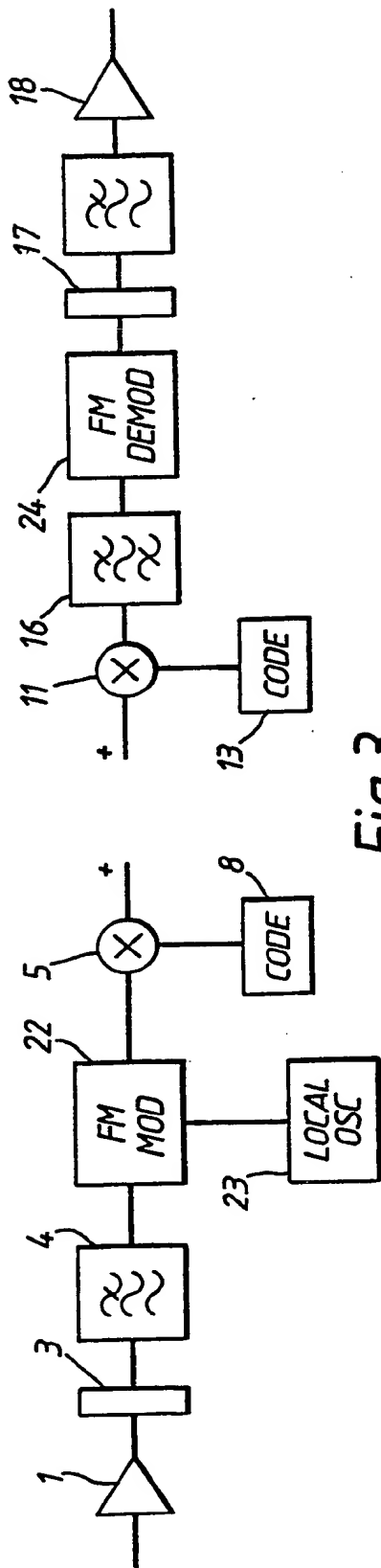


Fig.2

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## IMPROVEMENTS IN OR RELATING TO COMMUNICATION SYSTEMS

This invention relates to communication systems and more especially it relates to spread spectrum communication systems.

Spread spectrum or Code Division Multiple Access (CDMA) techniques for providing multiple access to a plurality of users over single channel is well known. Conventionally, channel information for each channel user is digitised and thereafter spread across the available channel bandwidth in accordance with a predetermined spreading code, a different unique code being for each user. De-spreading at a receiver is effected using the same unique code. After de-spreading the signal is processed to reverse the digitisation process thereby to provide a received analogue signal.

This known spread spectrum communication technique tends to be somewhat complex and accordingly the present invention has for an object to provide a simplified system.

According to the present invention a spread spectrum communication system comprises a transmitter including means for producing an analogue signal for transmission, a spreading code generator and mixer means to which a spreading code produced by the said generator and the analogue signal for transmission are fed, thereby to produce a spread spectrum signal for transmission, the system further comprising a receiver including a mixer to which a received spread spectrum signal is fed, a de-spreading code generator adapted and arranged to

produce a de-spreading code corresponding to the spreading code, thereby to produce a received analogue signal corresponding to the transmitted analogue signal, a unique code being used for each user of the system.

By applying at the transmitter a spreading code directly to the analogue signal without digitisation, a considerable simplification of the system is achieved, especially since signal processing to reverse the digitisation process at the receiver becomes unnecessary.

The spread spectrum signal for transmission might comprise a channel signal for onward radio transmission or alternatively onward line transmission. Conversely the received spread spectrum signal may be derived from a radio signal or alternatively a line transmission signal in accordance with the chosen transmission function.

The analogue signal may be fed to the mixer means in the transmitter via apparatus which comprises the serial combination of a buffer amplifier, signal conditioning means and filter means, and in the receiver the mixer means may be arranged to feed the received analogue signal via apparatus which comprises the serial combination of filter means, signal conditioning means and a buffer amplifier, thereby to provide a received analogue output signal.

The signal conditioning means may comprise in the transmitter a differentiator and in the receiver an integrator.

The analogue signal may comprise a base band sampled signal, the filter being arranged to feed the mixer means in the

transmitter via a sample and hold circuit, appropriate signal re-insertion means being provided in the receiver after the filter.

Alternatively, the analogue signal may comprise a frequency modulated (FM) signal, the filter being arranged to feed the mixer in the transmitter via a frequency modulator fed with a suitable local oscillator, the receiver including an FM de-modulator.

In a further alternative arrangement, the analogue signal may comprise an amplitude modulated (AM) or single side band (SSB) signal, in which case the mixer may be arranged to be fed in the transmitter via an AM or SSB modulator fed with an appropriate local oscillator, the receiver being arranged to include an appropriate AM or SSB de-modulator.

Some embodiments of the invention will now be described by way of example only with reference to the accompanying drawings in which;

FIGURE 1 is a somewhat schematic block diagram of a spread spectrum communication system;

FIGURE 2 is a schematic block diagram of a spread spectrum communication system for sampled base band operation;

FIGURE 3 is a block diagram of a spread spectrum communication system for FM operation; and

FIGURE 4 is a block schematic diagram of a spread spectrum communication system suitable for AM or SSB operation.

Referring now to Figure 1, a spread spectrum communication system comprises transmitter apparatus 1 and receiver apparatus 2. Although not shown in the drawing, communication between the transmitter and the receiver may be



either via line communication or radio. In the latter case signals produced may be amplified and frequency up converted through appropriate intermediate frequency stages in accordance with techniques which are well understood by those skilled in the art.

Referring now to the drawing, the transmitter comprises a buffer amplifier 1 to which analogue signals for transmission are fed via a line 2. Signals from the buffer amplifier are fed to a signal conditioner 3 which may comprise a differentiator, for example. Signals from the differentiator 3 are fed to a filter 4, which is shown in the drawing as a low pass filter. Signals from the aliasing filter 4 are fed to a mixer 5 via a line 6, the mixer 5 being fed also with a code signal on a line 7 from a spreading code generator 8. It will be understood that an output signal will be produced from the mixer on a line 9 wherein the available channel bandwidth is occupied by a number of channel users, each user being assigned a unique spreading code whereby CDMA is effected.

Conversely, at the receiver 2, received spread spectrum signals on a line 10, which may have been received via a line communication system or a radio communication system, including appropriate stages of IF amplification, are fed to a mixer 11 which is also fed via a line 12 with a de-spreading code which corresponds to the code produced by the code generator 8 and this association is indicated by means of a broken line 14, whereby an output signal from the mixer 11 is produced on a line 15 which corresponds substantially to the signal on the line 6 fed to the mixer 5. The de-spread signal on the line 15 is fed via a

filter 16 and a signal conditioning unit 17 which in the present case is an integrator, the integrator being arranged to feed an amplifier 18 which provides an output analogue signal on the line 19 corresponding to the signal in the transmitter fed to the buffer amplifier 1.

It will be appreciated that an arrangement as hereinbefore described with reference to Figure 1, represents a considerable simplification over known techniques which hitherto have required the provision of digitisation apparatus in the transmitter and corresponding apparatus in the receiver to reverse the digitisation process.

The invention lends itself to implementation in various forms, as shown for example in Figure 2, Figure 3 and Figure 4, wherein corresponding parts bear the same numerical designations as Figure 1, where appropriate, which implementations comprise a sampled base band implementation, an FM implementation and AM/SSB implementation respectively.

Referring firstly to Figure 2, a sampled base band system is provided by arranging for the aliasing filter 4 to be coupled to the mixer 5 via a sample and hold circuit 20. A corresponding filter 21 which in effect reverses the sample and hold process is coupled between the filter 16 and the signal conditioning unit 17 in the receiver 2.

In an alternative arrangement narrow or wide band frequency modulation is provided for by the provision of a frequency modulator 22 which is coupled between the filter 4 and the mixer 5, the frequency modulator being fed from a local

oscillator 23 which provides a carrier frequency. In order to provide for demodulation, a frequency demodulator 24 is included in the receiver between the filter 16 and the signal conditioner 17.

In a further alternative embodiment of the invention, AM or SSB may be provided for by connecting between the filter 4 and the mixer 5, an AM modulator or SSB modulator 25 which is arranged to feed the mixer 5 via a filter 26. In accordance with established techniques the AM or SSB modulator 25 is fed from a local oscillator generator 27. With the arrangement as shown in Figure 4, in order to provide for demodulation at the receiver an AM or SSB demodulator 28 is provided coupled between the mixer 11 and the signal conditioner 17.

As will be appreciated by the cognoscenti, various modifications may be made to the arrangements herein described without departing from the scope of the invention and for example, any suitable form of line communication or radio communication system may be provided in a channel between the transmitter 1 and the receiver 2 in accordance with the particular application in view.

## CLAIMS

1. A spread spectrum communication system comprising a transmitter including means for producing an analogue signal for transmission, a spreading code generator and mixer means to which a spreading code produced by the said generator and the analogue signal for transmission are fed, thereby to produce a spread spectrum signal for transmission, the system further comprising a receiver including a mixer to which a received spread spectrum signal is fed, a de-spreading code generator adapted and arranged to produce a de-spreading code corresponding to the spreading code, thereby to produce a received analogue signal corresponding to the transmitted analogue signal, a unique code being used for each user of the system.

2. A communication system as claimed in claim 1, wherein the spread spectrum signal for transmission comprises a channel signal for onward radio transmission or alternatively onward line transmission.

3. A communication system as claimed in claim 1, wherein the received spread spectrum signal is derived from a radio signal or alternatively a line transmission signal.

4. A communication system as claimed in any preceding claim, wherein the analogue signal is fed to the mixer means in the transmitter via apparatus which comprises the serial combination of a buffer amplifier, signal conditioning means and filter means, and in the receiver the mixer means is arranged to feed the received analogue signal via apparatus which comprises the serial combination of filter means, signal conditioning means and a buffer amplifier, thereby to provide a received analogue output signal.

5. A communication system as claimed in any preceding claim, wherein the signal conditioning means comprises in the transmitter a differentiator and in the receiver an integrator.

6. A communication system as claimed in any preceding claim, wherein the analogue signal comprises a base band sampled signal, the filter being arranged to feed the mixer means in the transmitter via a sample and hold circuit, appropriate signal reinsertion means being provided in the receiver after the filter.

7. A communication system as claimed in any of claims 1 to 5, wherein the analogue signal comprises a frequency modulated (FM) signal, the filter being arranged to feed the mixer in the transmitter via a frequency modulator fed with a suitable local oscillator, the receiver including an FM de-modulator.

8. A communication system as claimed in any of claims 1 to 5, wherein the analogue signal comprises an amplitude modulated (AM) or single side band (SSB) signal, the mixer being arranged to be fed in the transmitter via an AM or SSB modulator fed with an appropriate local oscillator, the receiver being arranged to include an appropriate AM or SSB de-modulator.

9. A communication system as claimed in claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977

**Examiner's report to the Comptroller under  
Section 17 (The Search Report)**

- 10 -

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**Relevant Technical fields**

(i) UK CI (Edition 2 L) H4L (LBSF)

(ii) Int CI (Edition 5) HO4B 7/216; HO4J 13/00

**Databases (see over)**

(i) UK Patent Office

(ii) ONLINE: WPI

Search Examiner

N W HALL

Date of Search

18 MAY 1993

Documents considered relevant following a search in respect of claims

1-9

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	US 4358844 (PIRANI) - whole document	1-5,7
X	GB 1572454 (T.R.T.) - whole document: see page 1 line 45	1
X	GB 934013 (C.I.T.) - whole document	1-3,8

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